Improving structural engineering and resiliency in New Zealand

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US-Japan-NZ Workshop
Nara, Japan
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New Zealand is vulnerable
23 January 1855
M_w c8.3
NZ Earthquakes

Murchison 1929
Napier Nurses Home 1931

Large New Zealand Earthquakes
Notable shallow (generally less than 30km deep) earthquakes since 1848

- 2 March 1887: Edgecumbe (Nelson) - Magnitude 6.5
- 23 January 1855: Wairarapa - Magnitude 8.2
- 3 February 1931: Hawke’s Bay - Magnitude 7.3
- 13 February 1931: Hawke’s Bay - Magnitude 7.3
- 6 February 1995: East Cape - Magnitude 7.0
- 5 March 1934: Pahiatua - Magnitude 7.6
- 20 December 2007: Gisborne - Magnitude 6.8
- 23 February 1863: Hawke’s Bay - Magnitude 7.5
- 23 March 1888: North Canterbury - Magnitude 7.3
- 17 June 1929: Murchison - Magnitude 7.8
- 16 October 1868: Cape Farewell - Magnitude 7.5
- 9 March 1929: Arthur’s Pass - Magnitude 7.1
- 15 July 2009: Dusky Sound - Magnitude 7.8
- 24 May 1958: Inangahua - Magnitude 7.1
- 22 August 2003: Fiordland - Magnitude 7.1
- 23 November 2004: Puysegur Trench - Magnitude 7.2
- 30 September 2007: Auckland Islands - Magnitude 7.3
- 13 June 2011: Christchurch - Magnitude 6.0
- 23 December 2011: New Brighton - Magnitude 6.0
- 16 August 2013: Grassmere - Magnitude 6.6
- 21 July 2013: Cook Strait - Magnitude 6.5
- 24 June 2012: Wairarapa - Magnitude 7.2
- 22 February 2011: Christchurch - Magnitude 6.3
- 4 September 2010: Darfield - Magnitude 7.1
- 22 February 1933: Napier - Magnitude 6.9
- 2 March 1987: Edgecumbe (Nelson) - Magnitude 6.5
**The Canterbury experience**

**Fatalities** – 185 (11,000 injured)  **Cost** – $NZ40 billion ≈ 20% GDP

**Christchurch** – 2 major collapses, 1700 commercial buildings demolished, 170k residential properties damaged, 8,000 red zoned
Canterbury - Many lessons

➢ Importance of:
  • resilience
  • knowledge of existing building stock (earthquake-prone)
  • integrated design process and monitoring
  • collaboration
  • engineering – ‘engineering matters’
    • structural design
    • ground conditions & geotech design
  • preparedness – 4Rs
Canterbury repair and rebuild

Residential guidance
Liquefaction
Slope stability
Risk approach – available resources

Industrial guidance
Keeping businesses operating
Foundation design

Seismicity review
Time varying hazard
Learning from Canterbury – geotechnical

- planning and building guidance – areas subject to liquefaction
- earthquake geotechnical engineering modules on:
  - geotechnical investigation for liquefaction assessment
  - foundation and retaining wall design
  - ground improvement methods and specifications
  - rockfall protection structures
  - slope stability
- National Geotechnical Database
  - Successful Canterbury database
  - Capture data once, reuse many times
  - Much better understanding of land and likely behaviour
Learning from Canterbury – structure

- review of structural provisions in Building Code – specificity of performance requirements & what is tolerable to society
- structural design standards reviews – design actions, concrete, steel, timber
- non-structural building elements (eg ceilings)
- low damage building technologies (eg base isolation)
Existing buildings – safer & more resilient earthquake-prone buildings legislation

• New legislation – the Building (Earthquake-Prone Buildings) Amendment Act 2016
• Balance of life safety, costs, heritage, resources
• Previously local govt policies, now national requirements
• varies the timetable for strengthening buildings relative to earthquake risk
• review of building assessment guidelines – displacement methods preferred

<table>
<thead>
<tr>
<th>Seismic risk area</th>
<th>TAs identify potentially EQP</th>
<th>Owners strengthen/ demolish EQP</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Priority</td>
<td>Other</td>
</tr>
<tr>
<td>High</td>
<td>2 ½ years</td>
<td>5 years</td>
</tr>
<tr>
<td>Medium</td>
<td>5 years</td>
<td>10 years</td>
</tr>
<tr>
<td>Low</td>
<td>n/a</td>
<td>15 years</td>
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Better management of buildings in an emergency

• MBIE has new functions around building management in an emergency
• preparing guidance for councils on the rapid building assessment process for emergencies (assessment and demolition protocols)
• training building assessors in rapid building assessment (400 trained nationally)
• guidelines for building failure investigations
• Detailed Damage Evaluation guidance
Research to improve building performance

- MBIE, Natural Hazards Research Platform, QuakeCoRE, QuakeCentre, National Science Challenges

- research projects on the performance and resilience of buildings:
  - residual capacity of buildings
  - performance of concrete walls
  - geotechnical (liquefaction and slope stability of Wellington hillsides)
  - economic research into the costs and benefits of increasing the structural performance requirements in the Building Code

- international collaboration
  - MBIE Chair in Earthquake Engineering
  - International Wall Institute
  - Joint Laboratory of Earthquake Engineering, Tongji
Designer competence and occupational regulation

- building failures in Canterbury - increased accountability of engineers
- upskilling engineers
- Code of Ethics review
- Body of Knowledge
- occupational regulation of engineers
- Liability
Goal: Safe resilient and affordable homes and buildings

Southland Stadium
September 2010

CTV Collapse Feb 2011

Weathertightness issues
**Sustaining collaboration**

- interdisciplinary collaboration to recognise and mitigate hazards
  - occurs naturally during disasters
  - needs mechanisms to encourage in peacetime
- helps with political process – support
- co-operation needed in crisis – trust
- Engineering Advisory Group
- memoranda of understanding with professional societies
Built Environment Leaders Forum 2015 & Action Plan

• Key government & private sector decision makers reflecting on lessons from Canterbury

• Develop Action plan for improving resilience on NZ built environment – five recommended areas
  • governance and leadership
  • decision-making frameworks
  • incentives and tools
  • Public engagement and communication
  • Information: data and evidence
Future challenges for improving structural engineering and resiliency in NZ

- identifying and protecting critical infrastructure
- adapting our buildings and infrastructure to climate change, sea level rise, coastal erosion and storm surges
- globalisation of supply chains – compliance and quality assurance
- better integrating regulations and design of buildings, land use and infrastructure
Leonard Cohen’s Anthem:

Ring the bells for those that ring, forget your perfect offering, there is a crack, a crack in everything. That’s how the light gets in.

Japanese practice of kintsukuroi ‘to repair with gold’